

**“A STUDY ON THE HYMENOPTERAN DIVERSITY WITH SPECIAL  
REFERENCE TO ANTS (FORMICIDAE) OF KALAMASSERY  
MUNICIPALITY”**

Dissertation submitted to Mahatma Gandhi University

In partial fulfillment of the requirement for the award of the degree of

**BACHELOR OF SCIENCE IN ZOOLOGY**



**DEPARTMENT OF ZOOLOGY**

**BHARATA MATA COLLEGE**

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**CERTIFICATE**

This is to certify that the project entitled “**A STUDY ON THE HYMENOPTERAN DIVERSITY WITH SPECIAL REFERENCE TO ANTS (FORMICIDAE) OF KALAMASSERY MUNICIPALITY**” is a bonafide work done by Jismi Jose with Register No.170021037719 during 2019-20 in partial fulfilment of the requirements for the Bachelor Degree of Science in Zoology of M G University, Kottayam.

**Head of the Department**

**Dr. Priyalakshmi G**

## DECLARATION

I do hereby declare that the work embodied in the dissertation entitled “**A STUDY ON THE HYMENOPTERAN DIVERSITY WITH SPECIAL REFERENCE TO ANTS (FORMICIDAE) OF KALAMASSERY MUNICIPALITY**” submitted to the Mahatma Gandhi University, Kottayam in partial fulfillment for the award of bachelor of science in zoology is record of bonafide dissertation done by me under the supervision of Mrs. Aswini Venugopal Guest lecturer Bharata Mata College, Thrikkakara and no part of this work has been submitted for the award of any other Degree/ Diploma/ Associate-ship/ Fellow ship or any other similar title to any candidate of any university.

Place : Thrikkakara

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Date : 09/06/2020

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## **ABSTRACT**

Ants are the most abundant and ecological significant organism on earth. They are the highly developed social insects. Present study deals with the diversity of ants in Kalamassery municipality, Kerala. It is a most populated municipality in kanayannur sub district. The main objective of the study was to collect ants from different sites and to study about their diversity. Ants were collected from different sites of kalamassery using all out search method, bait method, brush method, pit fall trap, hand collection and opportunistic method. The photographs of different ants were also taken. 20 species were collected from this region and are identified with the help of Rabeesh T P research scholar, Department of zoology, St. Xaviers college, Aluva. Among the subfamilies reported from the study area formicinae was dominant with 9 species followed by myrmicinae and ponerinae with 5 species and dolichoderinae with 1 species. The diversity is poor in Kalamassery due to high use of chemicals, varying climatic conditions, deforestation and urbanization. This study helps to know more about ant diversity at present and can compare it with the future. By increasing the biodiversity ant diversity can be increased in the study areas.

## INTRODUCTION

Ants are the most diverse, abundant and ecologically significant organisms on earth. Although their species richness appears to be greatest in the world tropics, the global patterns of ant diversity and distribution are not well understood (Wilkie *et al.*,2010).

Ants belong to the kingdom animalia, phylum arthropoda, class insecta, order hymenoptera and family formicidae. 7 subfamilies includes : Myrmicinae, leptaleinae, Dorylinae, Cerapachyinae, Ponerinae, Formicinae, Dolichoderinae (David .,2004).

Ants are excellent foragers and hard without any rest. Ants are probably the most highly developed social insects. Ants have no wings except in sexual forms in breeding season and therefore their job of travelling to long distances in search of food is very difficult but are addicted to work. A ant colony may have few thousand to over 5,00,000 individuals. About 3,500 species of ants are known which are adapted to live in colonies with caste differentiation. The nests are usually underground and are made of numerous passages and chambers and are called formic aria. The chambers are used as granaries for storing seeds and nurseries for rearing progeny.

Polymorphism is common in ants. Ant's colony consists of four main castes like queens, kings, workers and soldiers. Queens or gynes have large abdomen to lay a lot of eggs, males fertilize her. They are fertile females with well developed reproductive system. Larger than all other castes. It has two pairs of membranous wings that are shed after mating. Their sole duty is to lay eggs. Have lifespan of 15 or even 30 years. The ant colony has several queens, they may be large or macrogynes and small or microgynes. Kings or males or aners are fertile males with well developed reproductive system. They are smaller than the queens and soldier but larger than workers. Like queens males have two pair of wings. They serve to fertilize the queens. They are also dimorphic large sized macraners and small sized micraners. Workers or ergates are sterile females with reduced ,non functional reproductive system. They are smallest, wingless members and have broad sharp mandibles for cutting and chewing but eyes are small. Workers care for the eggs and larvae, collect food for other members of the colony, maintain proper temperature and humidity in the colony and construct and repair the nest. They are also dimorphic large sized macrergates and small sized micrergates. Soldiers or dinergates are modified workers but are



sterile females. They are wingless. Have large head with powerful mandibles for fighting. They defend the colony from the enemies by biting and stinging. They also crush seeds and fruits.

A typical colony consists of one or more egg laying queens, numerous sterile females(workers or soldiers) and winged sexual males and females. New colonies are established by males and young queens after their short mating flights. During which queen carries with her about half a dozen workers clinging to her legs.

The ants communicate with other ants by producing pheromones. Pheromones as chemical signals exchanged between individuals of same species which produces a specific reaction in the form of behavioural response or in a particular development process. Pheromones are detected by other ants through sense organs or the antennae. Pheromones are also called as ectohormones and are released in minute quantities bringing about major effect by functioning as chemical messengers. They are species specific released by exocrine glands. Pheromones satisfies following functions: Recognition of conspecific members, integration and regulation of colonies, sexual attraction and simulation, spotting out of food and mating partners and defence and protection. Little energy is required to synthesise pheromones. Pheromones are also effective even in darkness and they last for several hours (Dr.seema .,2019).

Ants come in all shapes, sizes and colors. They shows varied ways of life. But all ant species have something in common that is they are social insects which lives in organized colonies. Ants have six legs, exoskeleton is divided into three body segments like head, thorax, and the abdomen and they have no bones. They have hard exoskeleton which protects their organs. Head contains sharp mandibles. Mandibles stick to the head like two blades. Their function include carrying items, cutting and fighting (Petrie .,2010).

Ants have elbowed antennae with first segment being long and one or two segmented and nodiform or scale like pedicel following the propodeum. The head of the ant is variable in shape with well developed mandibles. The labrum is vestigial. The maxilla consists of all usual parts with toothless membranous laciniae and one to six segmented palpi. The labium consist of submentum, prementum, median glossa, a pair of paraglossae. The antennae are 4-13 segmented. Male have additional segment in each of the antennae than in the female or worker. Males possess well developed compound eyes and ocelli which are reduced or vestigial in workers and

females. The queens are longer with wings which are shed after nuptial flight. The males smaller and die soon after mating. Ants feed variously carnivorous, fungivorous, plants and seeds (David .,2004).

Ants play an important role within the terrestrial ecosystems because they have numerous interactions with different plant species, including seed dispersers, leaf and seed predators, and in some cases, as pollinators. Ants are found everywhere, except in Iceland, Greenland and Antarctica, but the number of species declines with increasing latitude, altitude and aridity. Currently there are 15,983 extant ant species or subspecies as per the recent classification. They are grouped into 20 subfamilies, with 464 genera. All of these belong to a single family called formicidae included in the super family vespoidea of the order hymenoptera, which is placed in the largest class insecta in the animal kingdom. A total of 828 valid species and subspecies names belonging to 100 genera are listed from India (Rabeesh *et al* .,2008).

Ants are important components of ecosystem not only because they constitute a great part of the animal biomass but also because they act as ecosystem engineers. Ant species can be used in monitoring environmental impacts, ecosystem funding, and tools in ecological studies. Ant species are used as excellent indicators of land management practices and restoration efforts. The food of ants consists of insects, terrestrial arthropods, excretion from plants, honey dew excreted by aphids and mealy bugs, secretion of the caterpillars of the family lycaenidae, seeds of plants etc. Every species of ant exert an immense impact on the environment. It directly or indirectly influences the development and destruction of flora and fauna of its surrounding environment (Azhagu raj *et al* .,2017).

An ant colony is built up by the queen ant. After its nuptial flight, a fertile queen finds a suitable nesting site for laying eggs. The eggs hatch into tiny larvae. The first batch of larvae is tended by the queen itself. The larvae change into pupal stage and finally the first batch of workers emerges. These workers then take up the responsibility of feeding the young ones-the larvae as well as the queen. The worker caste differentiates into soldier caste, foragers, feeders etc. and works on the principle of division of labour. During the reproductive phase of the colony the queen produces future queens and males. The queen may live upto 30 years, worker ants upto 60 days and males for few days. The queen ant produce a unique colony odour in each ant's nest thus, its members recognize nest mates from non- nest mates. Many of the ants have been

grouped on the basis of specific tasks performed by them. These include harvester ants, weaver ants, leaf cutter ants, army ants and fire ants (Bharti .,2012).

## **OBJECTIVES**

The present study attempts to explore the diversity of Hymenopterans (ants) in Kalamassery municipality with the following main objectives.

The study mainly focused on the following aspects:

- To find diversity of ants.
- Taxonomically classify the specimens collected.
- To find out the factors affecting ant diversity

## REVIEW OF LITERATURE

Tree macaranga in Asia shows good associations with ants. It gives nesting space for ants and seen as a ant partner. Ant species are attracted by extra floral nectarines (EFN) and food bodies. As colonization begins there started the lacking of nectarines. Earlier in the study it shows that the ant partners can save their macaranga plants against herbivore damage and vine cover. In the study food bodies were removed but the presence of little EFN herbivores like mites and caterpillar attack was minimum. Some macaranga species were attacked by shootborer. The most abundant ant species, *Crematogaster spp* were visiting the trees. The results of this study says that the associations of these ants were advantageous to macaranga plants and also the food bodies have only little attractive value than EFN. (Fiala *et al* .,1974)

Primary forests are now replaced with secondary forest and plantations. There is a clear reduction of biodiversity and cause great impacts to ecology. It mainly affect the related plants and animals. In the study they analyze how the diversity of ground foraging ant changes according to the changes in the Atlantic forest of Brazil. Body size, relative eye size, relative leg length and trophic position are the 4 factors they used for the study. They observed that is a positive relationship between species and the functional diversity. The increase of functional diversity of secondary forest is by rare species or functionally unique. (Bihn *et al* .,2010)

The factors like species richness and composition at multiple scales are important for conservation. In this study they evaluated how habitat heterogeneity both at local and landscape scales affect the ant diversity in the Brazilian cerrado. Cerrado, a biodiversity hotspot includes grassland, savannas, forests etc. They sampled ground dwelling ants in four habitats from a gradient of increasing tree cover and decreasing grass cover. Sampling shows that of the 12 sites 40 % of diverse fauna was found on one site. Fewer species in least complex habitat. Ant species diversity varies among those sites due to the variations of vegetation. They partitioned overall ant species richness into:  $\alpha$ 1(diversity within sampling sites),  $\beta$ 1(diversity among sites within the same habitat type), $\beta$ 2(diversity among sites from different habitats).  $\beta$ 2 is more than the

remaining components indicating that conservation of the Cerrado ant fauna depend mainly on the maintenance of habitat diversity.(Pacheco *et al* .,2012)

The Argentine ant *Linepithema humile* invaded the Hiroshima in south west Japan before 1990. In this study they discribed the distribution of exotic ant species and impacts on indigenous ant communities in urban areas. *humile L* is widely distributed in urban areas and vegetation of cities Hatsukaichi and Hiroshima. It reduced diversity of local ant communities, some ants disappeared in parks(*Pheidole noda*, *Pheidole indica*),some ants were less affected (*Paratrechina sakurae*, *Camponotus vitiosus*).(Touyama *et al* .,2003)

The changes in functional diversity in ant with environment conditions were investigated. Eight sites were sampled along a elevation gradient (1800-2550m). The variation were considered on the basis of four traits such as social structure, worker size, pupal development and nest structure. Ant species richness and functional diversity decrease with decreasing temperature. The phylogenetic diversity did not decrease at colder temperature. The ants in colder temperature lives in subterranean nests than the mounds and exhibit polymorphism in queen number either within or across population. The absence of mound building ants occurs as a result of the reduction of vegetal materials by coniferous trees. Severe abiotic conditions also act as a filter.(Reymond *et al* .,2013)

In this study litter ant diversity and their abundance in relation to abiotic and biotic factors were analysed at 5 primary forest sites lying between 300 to 1650meter above the mean sea level in the wayanad region of western ghats in kerala,south India. The presence of favourable physical conditions and abundance of prey resources results in ant abundance and species richness. Prey resource affect the ant distribution. Physical factors like moisture, humidity, temperature etc also affect ant distribution. This study highlights the need to consider site specific abiotic and biotic factors while examining the distribution patterns of litter ants along altitudinal gradients in other

regions of the western Ghats, a recognised hot spot of biodiversity with wide regional variation in vegetation types and faunal distribution patterns.(Sabu *et al* .,2008)

Study deals with diversity of ants in Kuttanad region of Kerala, India. Ants were collected from 6 sites of Kuttanad region. The methods used includes pitfall trap, brush method, sweep net and aspirator. 25 species were collected. 13 species of myrmicinae, 7 species of formicinae, 3 species of ponerinae, 1 each from dolichoderinae and pseudomyrmecinae. The high use of insecticides in the paddy fields cause the reduction of ant diversity.(Rabeesh *et al* .,2008)

The investigation was to explore the distribution of ants in two different areas of Thrissur district, Kerala. Collected ants belongs to subfamilies, most dominantly myrmicinae, formicinae, ponerinae, psuedomyrmicinae, dolichoderinae and dorylinae. In the study 19 species of ant were obtained as the maximum. This High species diversity was observed in agricultural area and minimum species diversity was recorded in industrial area. Number of species found in there is 12.(Gayathri *et al* .,2019)

Ants are diverse, widespread, abundant, important insect group in tropical and temperate ecosystems. The present study was done to explore the diversity and distribution of camponotus on Kerala. The study was done by field survey and sampling of specimens. *Camponotus campressus*(fabricius), *camponotus parius* Emery, *camponotus mitis*(smith) and *camponotus sericeus*(fabricius) was widespread. Maximum diversity of 18 species was recorded in Calicut district. This study also reviewed distribution and diversity of *camponotus mayr* in India. (John *et al* .,2016)

Silent valley national park (SVNP) is a tropical evergreen forest in India and also a natural heritage sites in the world. It comes under the core zone of nilgiri biosphere reserve of western Ghats. The study investigates the ground inhabiting ant diversity in SVNP. 6 different locations

were selected for sampling. Bait traps were used to collect ground dwelling ants. 30 genera representing 40 species of ant belonging to 6 families were collected and identified. Myrmicinae(12 genera and 12 species) was most abundant, formicinae(7 genera and 12 species), ponerinae(6 genera and 9 species) these 3 subfamilies was abundant with 83.33% of the genera and 87.50% of the species, and subfamilies dolichoderinae(3 genera and 3 species), both aenictinae and cerapachyinae (1 genus and 1 species) each. Pachycondyla (3 species), and polyrhachis (4 species) were the 2 most rich genera found which is similar observed in the western Ghats. Four invasive ants namely *anoplolepis gracilipes*, *monomorium sp.*, *paratrechina longicornis* and *tapinoma melanocephalum* were identified in the study area. This study also made efforts to study and document the existing ant fauna in different habitats and their role in the forest ecosystem.(Harsha *et al.* ,2018)

Ants are one of the most diverse groups of social insects. They act as ecological engineers. In this study ant species diversity and distribution in pachaiyappa's college for men campus Kanchipuram Tamil Nadu, India. With the help of baits, all out search method and hand collection method ant species are collected from 3 zones of the college. 10 species belonging to 9 genera, 4 subfamilies were recorded out of 4 subfamilies the formicinae(5 species) was dominant followed by myrmicinae(3 species), pseudomyrmicinae(1 species) and dolichoderinae (1 species). This study also proved that zone 1 and 2 were similar in ant species composition, diversity and species richness.(Azhagu raj *et al.* ,2017)



## MATERIALS AND METHODS

- **STUDY AREA**

The area for the study of ant diversity is Kalamassery municipality which includes Bharatha matha college near seaport-airport Rd, Thrikkakara premises and home premises. Kalamassery municipality is one of the most populated place in kanayannur sub district. Total geographical area is 27 km<sup>2</sup>. Yearly average rainfall received is 3053mm. 34°C and 22°C is the maximum and minimum temperature.

- **SAMPLING METHODOLOGY (collection techniques)**

Ants were collected during morning and evening. The collection started on december 10, 2019. Different methods used are

1. All out search method

This was common method helps to collect many species of ants. A test tube was carefully inverted over the ants and the trapped ant was transferred directly to the vials containing 70% alcohol. Ants can be searched anywhere and every specimen can be collected by using zero tip camlin brush.

2. Bait method

This method used for certain ants that can be attracted to specific food substances. A little quantity of food is taken in a watch glass. It is then placed anywhere in the ground. A large number of specimens were collected by this method. The ants attracted to the source are immediately put into a polythene bag inside which it is killed and preserved in 70% alcohol.

3. Brush method

Collection of small ants from leaf, ground, tree branches, and rocky crevices by using the help of a zero tip camelin brush soaked with 70% alcohol stick on ants and directly transferred to small vials containing 70% alcohol.

4. Pit fall trap

A plastic jar which can be submerged in the soil at the ground level in a suitable habitat. It is partially filled with soap solution. When the ants moving nearby the trap accidentally will fall in to the container , so that they can be collected.

5. Hand collection

This method was done by using small soft tipped forceps for collecting large ants from their micro habitat. Turning over stones and logs exposes many ants. This method was mostly used for sampling because the specimen can be easily collected.

6. Opportunistic method

The specimen were collected from whenever and wherever found during the study period using hands.

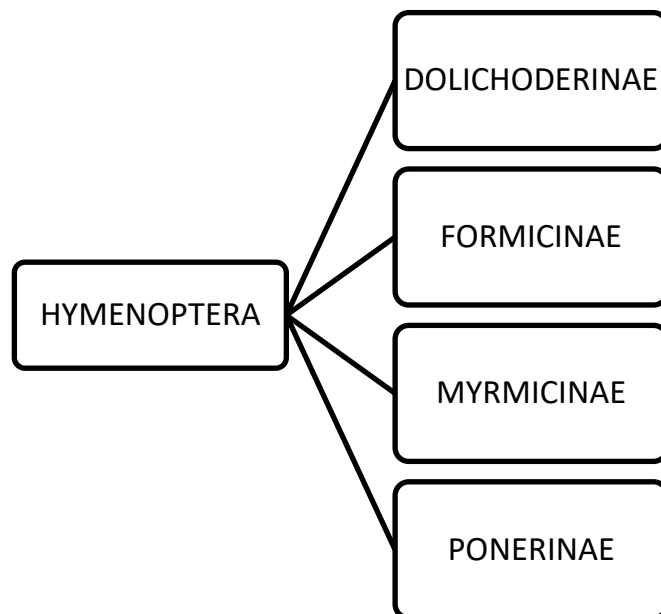
The collected ants are cleaned from debris. They are sorted based on difference in size ,shape colour and other morphological characters. Small clean bottles were selected for storing ants. Each sorted groups are placed in separate bottles containing 70% alcohol (isopropyl alcohol). Ants are identified under the guidance of Rabeesh T P research scholar , Department of zoology, st. xaviers college, Aluva.

## RESULT

### **SPECIES RICHNESS IN KALAMASSERY MUNICIPALITY (K M)**

From the current field study, a total of 20 ants species coming under 12 genera belonging to 4 subfamilies were sighted in Kalamassery Municipality (Table 1). Among them all were identified up to species level and genus level. They fall under 4 subfamilies such as formicinae, myrmicinae, ponerinae and dolichoderinae.

These types were identified up to the family level so they are represented as OTU (Operational Taxonomic unit)



### **List of Identified Specimens**

**Table 1: List of identified specimen from Kalamassery municipality**

<b>Sl No:</b>	<b>GENUS</b>	<b>SPECIES</b>	<b>Subfamily</b>
1	<i>Technomyrmex</i>	<i>albipes</i> (Smith)	Dolichoderinae
2	<i>Camponotus</i>	<i>mitis</i> (Smith)	Formicinae
3	<i>Paratrechina</i>	<i>longicornis</i> (Latreille)	Formicinae
4	<i>Oecophylla</i>	<i>smaragdina</i> (Fabricius)	Formicinae

5	<i>Anoplolepis</i>	<i>gracilipes</i> (Smith)	Formicinae
6	<i>Oecophylla</i>	<i>smaragdina</i> (Fabricius)	Formicinae
7	<i>Camponotus</i>	<i>mitis</i> (Smith)	Formicinae
8	<i>Prenolepis</i>	<i>Nitens</i> ( Mayr)	Formicinae
9	<i>Prenolepis</i>	<i>nitens</i> (Mayr)	Formicinae
10	<i>Prenolepis</i>	<i>nitens</i> (Mayr)	Formicinae
11	<i>Monomorium</i>	<i>pharaonis</i> ( Linnaeus)	Myrmicinae
12	<i>Myrmicaria</i>	<i>brunnea</i> (Saunders)	Myrmicinae
13	<i>Solenopsis</i>	<i>geminata</i> (Fabricius)	Myrmicinae
14	<i>Myrmicaria</i>	<i>brunnea</i> (Saunders)	Myrmicinae
15	<i>Pheidole</i>	<i>spathifera</i> (Forel)	Myrmicinae
16	<i>Diacamma</i>	<i>scalpratum</i> (Smith)	Ponerinae
17	<i>Odontomachus</i>	<i>simillimus</i> (Smith)	Ponerinae
18	<i>Diacamma</i>	<i>scalpratum</i> (Smith)	Ponerinae
19	<i>Odontomachus</i>	<i>simillimus</i> (Smith)	Ponerinae
20	<i>Diacamma</i>	<i>scalpratum</i> (Smith)	Ponerinae

#### 1. DOLICHODERINAE

The pedicel is single segmented and a constriction between the first and second segments of the gaster is wanting. These ants are capable of ejecting a foul smelling liquid from the anus. The identified species is:

- *Technomyrmex albipes*



Fig 1

## 2. FORMICINAE

The pedicel is single segmented and the anal orifice is terminal and circular. They are distributed widely. Many of the formicia species are mound builders. The ants of this group are commonly called as honeyants as they store in them the honeydew collected by other workers and such individuals are termed as repletes. The identified species is :

- *Camponotus mitis*



Fig 2

- *Paratrechina longicornis*



Fig 3

- *Oecophylla smaragdina*



Fig 4

- *Anoplolepis gracilipes*

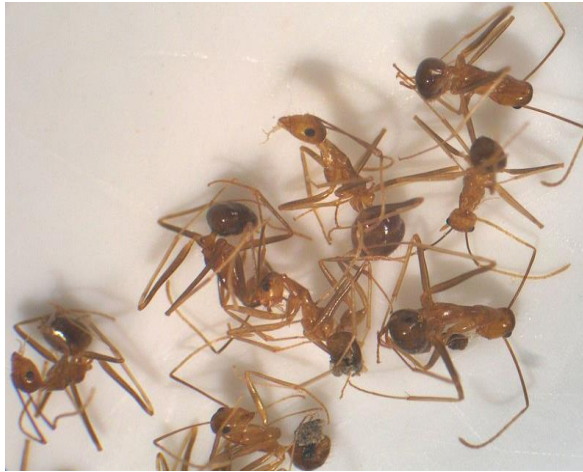


Fig 5

- *Prenolepis nitens*



Fig 6

### 3. MYRMICINAE

It is the largest subfamily and its members are characterised by two segmented pedicel. These ants feed on seeds and store them in their nests and hence known as harvester ants.

- *Monomorium pharaonis*



Fig 7

- *Myrmecaria brunnea*



Fig 8

- *Solenopsis geminata*



Fig 9

- *Pheidole spathifera*



Fig 10

#### 4. Ponerinae

The pedicel is single segmented and a distinct constriction between the first and second segments of the gaster is evident. These ants inhabit rotten logs, stumps or may live in the soil beneath various objects. They are carnivorous in habit.

- *Diacamma scalpratum*



Fig 11



- *Odontomachus simillimus*

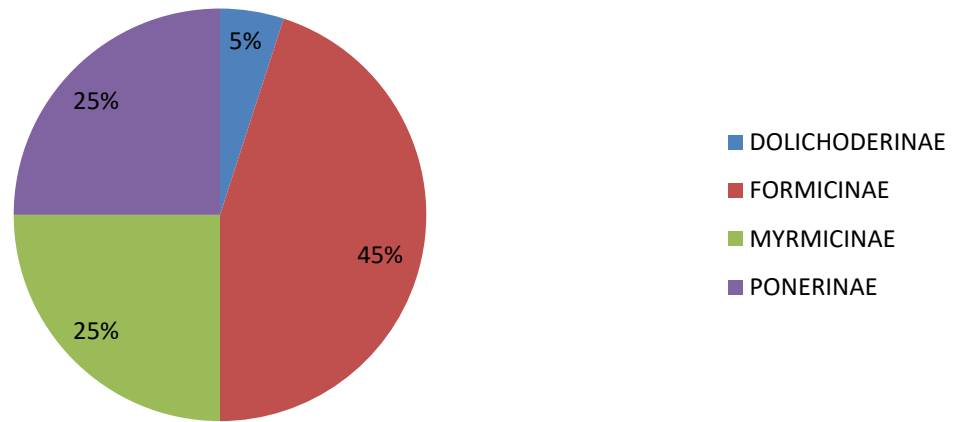


Fig 12

**Table 2 : Relative species abundance of the four subfamilies is represented with the help of a pie diagram.**

SL NO	SUBFAMILY	NUMBER OF SPECIES
1	DOLICHODERINAE	1
2	FORMICINAE	9
3	MYRMICINAE	5
4	PONERINAE	5

**PIE DIAGRAM SHOWING RELATIVE SPECIES ABUNDANCE OF FOUR SUBFAMILIES**



Formicinae is the dominated subfamily with 45% followed by myrmicinae and ponerinae with 25% each and 5% with dolichoderinae.

## DISCUSSION

This is the first attempt of a study on ant diversity in Kalamassery municipality a region of kerala. Kalamassery is a town in the Ernakulam district. It is a concentrated region of industrialization with several factories manufacturing chemicals and fertilizers as well as IT companies. Agricultural fields is very less compared to other municipalities. Forest areas is present in some parts of Kalamaserry. In the present study 20 species of ants were collected. Formicinae subfamily is highly dominated in the study area with highest rate of arboreal species. Because of the varying climatic conditions and anthropogenic activities like conversion of agriculture fields to buildings, use of pesticides, deforestation, urbanisation etc make soil unsuitable for the survival of ant species and hence ants can't tolerate such situations. *Camponotus mitis*, *Paratrechina longicornis*, *Oecophylla smaragdina*, *Anoplolepis gracilipes*, *Prenolepis nitens* were most abundant. This study enables one to know about the diversity of ants in the study area. It also helps to compare the diversity of ants in future. By improving better living conditions to ants the diversity can be improved.

## **CONCLUSION**

Ants are the most diverse, abundant and ecologically significant organisms on earth. Ants they help with pollination, help to control other insects, dig soil and gives better aeration and water penetration. Eventhough they have positive characters they also show some negative impacts such as they destroy crops, invade house and become pests, fire ants when disturbed become very dangerous. Environmental disturbance had a severly negative effect on ant diversity and abundance. This study was conducted from 10<sup>th</sup> December 2019. Ants were collected from Bharata Mata College, Thrikkakara, forest areas, home premises. 20 specimens were collected using all out search method, bait method, brush method, pit fall trap, hand collection, opportunistic method. They were stored in 70% alcohol and are identified with the help of Rabeesh TP research scholar, Department of zoology, st. xaviers college, Aluva. Of the 20 specimens 9 were from subfamily formicinae, 5 each from myrmicinae and ponerinae and 1 from dolichoderinae. Present study shows that Kalamassery regions suffer from threats such as high usage of chemicals, habitat alteration, deforestation, urbanization, varying climatic changes etc results in change in species diversity. The number of ant species can be increased by providing the ideal conditions such as food availability, nesting sites, open sites for foraging etc can improve the biodiversity.

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## **ABBREVIATION**

1. EFN - Extrafloral nectories
2. KM - Kalamassery municipality
3. OTU - Operational taxonomic unit
4. SVNP - Silent valley national park

